CLAIMS:

1. An apparatus for depositing a uniform coating on a surface of a substrate, said apparatus comprising:

a) at least one array of a plurality of plasma sources for generating a plurality of plasmas, wherein each of said plurality of plasma sources includes a cathode, an anode, and an inlet for a non-reactive plasma source gas disposed in a plasma chamber which is maintained at a first predetermined pressure;

b) a deposition chamber for containing said substrate, wherein said deposition chamber is in fluid communication with said plasma chamber, and wherein said deposition chamber is maintained at a second predetermined pressure, said second predetermined pressure being less than said first predetermined pressure; and

c) at least one reactant gas injector disposed in said deposition chamber for providing a differential flow rate of at least one reactant gas into each of said plurality of plasmas.

2. The apparatus according to Claim 1, wherein at least one of said plurality of plasma sources is an expanding thermal plasma source.

3. The apparatus according to Claim 1, wherein said at least one array includes at least one three dimensional array of said plurality of plasma sources.

4. The apparatus according to Claim 1, wherein said at least one array includes at least one linear array of said plurality of plasma sources.

5. The apparatus according to Claim 1, wherein said at least one array includes at least one two dimensional array of said plurality of plasma sources.

6. The apparatus according to Claim 1, wherein said first predetermined pressure is at least about 0.1 atmosphere.

7. The apparatus according to Claim 6, wherein said first predetermined pressure is about 1 atmosphere.

8. The apparatus according to Claim 1, wherein said second predetermined pressure is less than about 1 torr.

9. The apparatus according to Claim 1, wherein said second predetermined pressure is less than about 100 millitorr.

10. The apparatus according to Claim 1, wherein said plasma source gas comprises at least one of argon, nitrogen, hydrogen, helium, neon, krypton, and xenon.

11. A reactant gas injector for injecting at least one reactant gas into a plurality of plasmas generated by an array of a plurality of plasma sources such that a first flow rate of said reactant gas into a first plasma generated by a first plasma source in said array is different from a second flow rate of said reactant gas into a second plasma generated by a second plasma source in said array, said reactant gas injector comprising:

a) at least one reactant gas inlet comprising a tubular-walled structure having an interior space through which said at least one reactant gas is supplied from a reactant gas source;

b) a first plurality of orifices proximate to said first plasma, each of said first plurality of orifices extending through said tubular-walled structure from said interior space to an outer surface of said reactant gas inlet, wherein said first plurality of orifices is oriented such that said at least one reactant gas passes from said interior space through said first plurality of orifices and is directed into said first plasma; and

c) a second plurality of orifices proximate to said second plasma, each of said second plurality of orifices extending through said tubular-walled structure from said interior space to an outer

surface of said at least one reactant gas inlet, wherein said second plurality of orifices is oriented such that said at least one reactant gas passes from said interior space through said second plurality of orifices and is directed into said second plasma.

12. The reactant gas injector according to Claim 11, wherein said first plurality of orifices comprises a first predetermined number of orifices and said second plurality of orifices comprises a second predetermined number of orifices.

13. The reactant gas injector according to Claim 12, wherein said first predetermined number is different from said second predetermined number.

14. The reactant gas injector according to Claim 11, wherein said first plurality of orifices has a first linear density and said second plurality of orifices has a second linear density, wherein said first linear density is different from said second linear density.

15. The reactant gas injector according to Claim 12, wherein each of said first plurality of orifices has a first conductance, and each of said second plurality of orifices has a second conductance, said second conductance being different from said first conductance.

16. The reactant gas injector according to Claim 11, wherein said reactant gas injector comprises at least one ring injector.

17. The reactant gas injector according to Claim 11, wherein said reactant gas injector comprises a first reactant gas injector for injecting said reactant gas into said first plasma at a first predetermined flow rate and a second reactant gas injector for injecting said reactant gas into said second plasma at a second predetermined flow rate, wherein said first reactant gas injector is separate from said second reactant gas injector, and wherein at least one of said first predetermined flow rate and said second predetermined flow rate is independently controllable.

18. The reactant gas injector according to Claim 17, wherein said first predetermined flow rate is different from said second predetermined flow rate.

19. An apparatus for depositing a uniform coating on a non-planar surface of a substrate, said apparatus comprising:

a) at least one array of a plurality of plasma sources for generating a plurality of plasmas, wherein at least one of said plurality of plasma sources is an expanding thermal plasma source, wherein each of said plurality of plasma sources includes a cathode, an anode, and an inlet for a non-reactive plasma source gas disposed in a plasma chamber which is maintained at a first predetermined pressure;

b) a deposition chamber for containing said substrate, wherein said deposition chamber is in fluid communication with said plasma chamber, and wherein said deposition chamber is maintained at a second predetermined pressure, said second predetermined pressure being less than said first predetermined pressure; and

c) at least one reactant gas injector disposed in said deposition chamber for injecting at least one reactant gas into said plurality of plasmas such that a first flow rate of said at least one reactant gas into a first plasma generated by a first plasma source in said at least one array is different from a second flow rate of said at least one reactant gas into a second plasma generated by a second plasma source in said at least one array, said at least one reactor injector comprising: (i) at least one reactant gas inlet comprising a tubular-walled structure having an interior space through which said at least one reactant gas is supplied from a reactant gas source; (ii) a first plurality of orifices proximate to said first plasma, each of said first

plurality of orifices extending through said tubular-walled structure from said interior space to an outer surface of said reactant gas inlet, wherein said first plurality of orifices is oriented such that said at least one reactant gas passes from said interior space through said first plurality of orifices and is directed into said first plasma; and (iii) a second plurality of orifices proximate to said second plasma, each of said second plurality of orifices extending through said tubular-walled structure from said interior space to an outer surface of said at least one reactant gas inlet, wherein said second plurality of orifices is oriented such that said at least one reactant gas passes from said interior space through said second plurality of orifices and is directed into said second plasma.

20. The apparatus according to Claim 19, wherein said first plurality of orifices comprises a first predetermined number of orifices and said second plurality of orifices comprises a second predetermined number of orifices.

21. The apparatus according to Claim 20, wherein said first predetermined number is different from said second predetermined number.

22. The apparatus according to Claim 19, wherein said first plurality of orifices has a first linear density and said second plurality of orifices has a second linear density, wherein said first linear density is different from said second linear density.

23. The apparatus according to Claim 19, wherein each of said first plurality of orifices has a first conductance, and each of said second plurality of orifices has a second conductance, said second conductance being different from said first conductance.

24. The apparatus according to Claim 19, wherein said reactant gas injector comprises at least one ring injector.

25. The apparatus according to Claim 19, wherein said reactant gas injector comprises a first reactant gas injector for injecting said reactant gas into said first plasma at a first predetermined flow rate and a second reactant gas injector for injecting said reactant gas into said second plasma at a second predetermined flow rate wherein said first reactant gas injector is separate from said second reactant gas injector, and wherein at least one of said first predetermined flow rate and said second predetermined flow rate is independently controllable.

26. The apparatus according to Claim 25, wherein said first predetermined flow rate is different from said second predetermined flow rate.

27. The apparatus according to Claim 19, wherein said at least one array includes at least one three dimensional array of said plurality of plasma sources.

28. The apparatus according to Claim 19, wherein said at least one array includes at least one linear array of said plurality of plasma sources.

29. The apparatus according to Claim 19, wherein said at least one array includes at least one two dimensional array of said plurality of plasma sources.

30. The apparatus according to Claim 19, wherein said first predetermined pressure is at least about 0.1 atmosphere.

31. The apparatus according to Claim 30, wherein said first predetermined pressure is about 1 atmosphere.

32. The apparatus according to Claim 19, wherein said second predetermined pressure is less than about 1 torr.

33. The apparatus according to Claim 32, wherein said second predetermined pressure is less than about 100 millitorr.

34. The apparatus according to Claim 19, wherein said plasma source gas comprises at least one of argon, nitrogen, hydrogen, helium, neon, krypton, and xenon.

35. A method of depositing a uniform coating on a surface of a substrate, the method comprising the steps of:

a) providing the substrate having the surface to a deposition chamber;

b) evacuating the deposition chamber to a predetermined deposition pressure;

c) generating a plurality of plasmas from at least one array of a plurality of plasma sources;

d) injecting at least one reactant gas into each of the plurality of plasmas such that a first flow rate of the at least one reactant gas into a first plasma is different from a second flow rate of the at least one reactant gas into a second plasma;

e) flowing the at least one reactant gas and the plurality of plasmas into the deposition chamber toward the substrate; and

f) reacting the at least one reactant gas with each of the plurality of plasmas to form the coating on the surface of the substrate.

36. The method according to Claim 35, wherein at least one of the plurality of plasma sources is an expanding thermal plasma source having a cathode, an anode, and an inlet for a non-reactive plasma source gas disposed in a plasma chamber that is in fluid communication with the deposition chamber.

37. The method according to Claim 36, wherein the step of flowing the at least one reactant gas and the plurality of plasmas into the deposition chamber toward the substrate includes the steps of:

a) maintaining the deposition chamber at a predetermined deposition pressure, the deposition pressure being greater than a first pressure of the plasma chamber; and

b) expanding the plurality of plasmas into the deposition chamber toward the substrate.

38. The method according to Claim 35, wherein the step of injecting a reactant gas into the plurality of plasmas comprises:

a) supplying the at least one reactant gas from at least one reactant gas source to at least one reactant gas injector;

b) passing the at least one reactant gas through a first plurality of orifices in the at least one reactant gas injector proximate to the first plasma and a second plurality of orifices proximate to the second plasma;

c) directing the at least one reactant gas through the first plurality of orifices into the first plasma; and

d) directing the at least one reactant gas through the second plurality of orifices into the second plasma.

39. The method according to Claim 38, wherein the first plurality of orifices comprises a first predetermined number of orifices and the second plurality of orifices comprises a second predetermined number of orifices, and wherein the first predetermined number is different from the second predetermined number.

40. The method according to Claim 38, wherein each of the first plurality of orifices has a first conductance and each of the second plurality of orifices has a second conductance, wherein the first conductance is different form the second conductance.

41. The method according to Claim 38, wherein the step of supplying the at least one reactant gas from a reactant gas source to at least one reactant gas injector comprises:

a) supplying the at least one reactant gas from a reactant gas source to a first reactant gas injector for injecting the at least

one reactant gas into the first plasma at a first predetermined flow rate; and

b) supplying the at least one reactant gas from a reactant gas source to a second reactant gas injector for injecting the at least one reactant gas into the second plasma at a second predetermined flow rate, wherein the first reactant gas injector is separate from the second reactant gas injector, and wherein at least one of the first predetermined flow rate and the said second predetermined flow rate is independently controllable.

42. The method according to Claim 41, further including the step of independently controlling at least one of the first predetermined flow rate and the second predetermined flow rate such that the first predetermined flow rate is different from the second predetermined flow rate.

43. A method of injecting at least one reactant gas into a plurality of plasmas generated by an array of a plurality of plasma sources such that a first flow rate of the at least one reactant gas into a first plasma is different from a second flow rate of the at least one reactant gas into a second plasma, the method comprising the steps of:

a) supplying the at least one reactant gas from a reactant gas source to at least one reactant gas injector;

b) passing the at least one reactant gas through a first plurality of orifices in the at least one reactant gas injector proximate to the first plasma, wherein the first plurality of orifices is oriented such that the at least one reactant gas is directed into the first plasma at a first predetermined flow rate; and

c) passing the at least one reactant gas through a second plurality of orifices in the at least one reactant gas injector proximate to the second plasma, wherein the second plurality of orifices is

oriented such that the at least one reactant gas is directed into the second plasma at a second predetermined flow rate.

44. The method according to Claim 43, wherein the step of passing the at least one reactant gas through a first plurality of orifices in the at least one reactant gas injector comprises passing the at least one reactant gas through a first predetermined number of orifices, and wherein the step of passing the at least one reactant gas through a second plurality of orifices comprises passing the at least one reactant gas through a second predetermined number of orifices.

45. The method according to Claim 44, wherein the first predetermined number is different from the second predetermined number.

46. The method according to Claim 43, wherein each of the first plurality of orifices has a first conductance, and each of the second plurality of orifices has a second conductance, and wherein the second conductance is different from the first conductance.

47. The method according to Claim 43, wherein the step of supplying the at least one reactant gas from a reactant gas source to at least one reactant gas injector comprises:

a) supplying the at least one reactant gas from a reactant gas source to a first reactant gas injector for injecting the at least one reactant gas into the first plasma at a first predetermined flow rate; and

b) supplying the at least one reactant gas from a reactant gas source to a second reactant gas injector for injecting the at least one reactant gas into the second plasma at a second predetermined flow rate, wherein the first reactant gas injector is separate from the second reactant gas injector, and wherein at least one of said first predetermined flow rate and said second predetermined flow rate is independently controllable.

48. The method according to Claim 47, further including the step of independently controlling at least one of the first predetermined flow rate and the second predetermined flow rate such that the first predetermined flow rate is different from the second predetermined flow rate.

49. A non-planar substrate having a uniform coating deposited on a surface, wherein the uniform coating is deposited by:

a) providing the substrate having the surface to a deposition chamber, wherein the deposition chamber is in fluid communication with at least one array of a plurality of plasma sources, wherein at least one of the plurality of plasma sources is an expanding thermal plasma source having a cathode, an anode and an inlet for a non-reactive plasma source gas disposed in a plasma chamber, the plasma chamber being in fluid communication with the deposition chamber;

b) evacuating the deposition chamber to a predetermined deposition pressure and the plasma chamber to a predetermined first pressure, wherein the predetermined deposition pressure is less than the predetermined first pressure;

c) generating a plurality of plasmas in the plurality of plasma sources and flowing the plurality of plasmas into said deposition chamber;

d) injecting at least one reactant gas into each of the plurality of plasmas as the plurality of plasmas flows into the deposition chamber such that a first flow rate of the at least one reactant gas into a first plasma is different from a second flow rate of the at least one reactant gas into a second plasma;

e) flowing the at least one reactant gas and the plurality of plasmas into the deposition chamber toward the substrate; and

f) reacting the at least one reactant gas with each of the plurality of plasmas to form the coating on the surface of the substrate.